PEST MANAGEMENT GRANTS FINAL REPORT

Title: Pre-irrigation Followed by Cultivation or Flaming to Deplete the Weed Seed Bank prior to Crop Planting

Agreement Number: 01-0207C

Principal Investigators:

W.T. Lanini	Steven Fennimore	Tomas Stevenson
Weed Ecologist	Extension Specialist	Graduate Student
Weed Science Program	U.C. Davis	U.C. Davis
University of California	c/o USDA Research Station	124 Robbins Hall
One Shields Ave.	1636 E. Alisal St.	Davis, CA 95616
Davis, CA 95616	Salinas, CA 93905	(530) 756-6573
(530) 752-4476, voice	(831) 755-2896, voice	tomasstevenson@hotmail.com
(530) 752-4604, fax	(831) 755-2814, fax	
lanini@vegmail.ucdavis.edu	safennimore@ucdavis.edu	

Contractor: University of California, Davis

Date: April 25, 2003

Prepared for the California Department of Pesticide Regulation

Disclaimer: The statements and conclusions in this report are those of the contractor and not necessarily those of the California Department of Pesticide Regulation. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such product.

Acknowledgements:

We thank, Shachar Shem-Tov, Juan Carlos Brevis, Mario Miranda, Ernie Roncoroni, Andrew Rumsey, Carl Edwards, Jose A. Valdez, Kathy Roth, Diego Renteria, Gonzalo Saavedra, Jaime Saavedra, Tony Arellano, for their hard work. We also thank Sharon Benzen, Gerardo Ochoa, and Jim Jackson for their technical support.

This report is submitted in fulfillment of DPR agreement number 01-0207C, titled "Pre-irrigation followed by cultivation or flaming to deplete the weed seed bank prior to crop planting", by the University of California, Davis, under the sponsorship of the California Department of Pesticide Regulation. Work was completed as of April 1, 2003.

Table of Contents:

Executive Summary

Pre plant irrigation is a common practice during field preparation. Irrigation prior to crop planting may be a way to stimulate weed emergence so that weeds can be killed by tillage, prior to seeding. Our hypothesis is that if the upper layers of the seedbank can be depleted prior to planting, fewer weeds will emerge during the crop production cycle. Therefore, preirrigation could reduce the amount of herbicide required for effective weed control. We compared weed emergence in tomato and lettuce beds that had no preirrigation (control) to beds that had been preirrigated once by furrow or sprinkler irrigation one or two week prior to shallow tillage and crop planting. In each of the pre-irrigation treatments, three levels of preemergence herbicide were applied (0, 0.5X and 1.0 X rate). Weed densities 21d after planting and the time required to weed the crops was measured. Weed densities and hand weeding time were generally reduced by the preirrigation treatments compared to the no preirrigation. Where a 7d preplant interval was used, sprinkler irrigation was the most effective method to deplete weed emergence in Salinas. Where a 14d preplant interval was used, weed densities in the control plots were twice those in the preirrigated plots regardless of irrigation type. Weeding times of tomato and spring-planted lettuce in the furrow and sprinkler irrigated plots were reduced by 37 to 90% compared to the control. Differences between the preirrigation treatments and the control were significant regardless of whether 0.5 or 1.0 rates of herbicide were applied. However, no significant differences were found between these two rates, i.e. this suggests that the herbicide rate could be reduced. Preirrigation methods improved crop stand but not the final crop yield in lettuce.

Introduction

Pre-irrigation has been utilized in weed management strategies for reducing weed seed prior to crop planting. Benefits have included reduced herbicide inputs or tillage operations necessary for subsequent weed control. However, a better understanding of this technique is needed for wider acceptance among growers. The objective of this research is to determine the most effective pre-irrigation strategy followed by either cultivation or flaming for effective weed seed depletion prior to planting. Two field trials (lettuce and tomato) were conducted at Davis, and two trials (lettuce) at Salinas California, to evaluate pre-irrigation followed by weed removal prior to crop planting.

Materials and methods

Davis: Field trials were conducted at Davis, California, in the summer and fall, 2002. The study utilized a split-split plot design with pre-irrigation methods as main plots. Main plots were 27ft (8 – 40" beds) by 200ft for lettuce and 60ft (12 – 60" beds) by 200ft for tomato. The main plots were sprinkler (1 inch of water), furrow or no pre-irrigation (Figure 1). The first split of the main plots was weed removal method after pre-irrigation; weed removal was performed at either 10 or 17 days after pre-irrigation using either flaming (propane) or shallow cultivation (Figure 2). Four flaming units were used per beds in order to cover the whole bed. Depth of cultivation was one inch. The second split was the herbicide program used: Lettuce - full label rate pronamide pre-emergence (2 lb ai/a); half label rate pronamide (1 lb ai/A); and a third treatment without herbicide. Tomato - full label rate rimsulfuron post-emergence (0.5 oz ai/a) and trifluralin layby (0.75 lb/a); half label rate rimsulfuron post-emergence (0.25 oz ai/a) and trifluralin layby (0.375 lb/a); and a third treatment with no herbicide (Figure 3).

Weed density was measured 14 days (lettuce trial) and 18 days (tomato trial) after crop planting. Three samples per plot were randomly made with a $0.25m^2$ frame and the number of weeds per sample was recorded. Each plot was hand weeded and the weeding time for each plot was measured. Lettuce was hand harvested, from a 10-foot random section per plot. The total weight of this sample was measured. The wrapper leaves were then removed leaving the marketable lettuce heads; the number of marketable heads were counted and total weight of these heads was measured. Tomato was machine harvested and total fruit weight measured. Three random samples were taken directly from the conveyer belt in order to determine the percent of red, green and rotten tomatoes per plot.

Salinas: Preirrigation experiments were repeated twice; once for spring-planted lettuce at Spence farm and once for fall-planted lettuce at Hartnell farm. Preirrigation was conducted on raised beds using furrow or sprinkler irrigation and a control that was not preirrigated. After 7 or 14 days, beds were tilled, shaped and seeded with romaine lettuce (var. Salinas green tower). Three replications of the preirrigation treatments were arranged in a Latin square block design that were split for the pre planting time interval and split for the herbicide treatments. Herbicide treatment included application of three levels of preemergence herbicide (pronamide) at rates of 0, 0.60 and 1.20 lb ai/a, with or without application of 2% v/v glyphosate prior to crop emergence (4 days after crop seeding). Glyphosate application was not repeated in the fall-planted lettuce, based on the results of the spring study. Replicate size was a two 1m wide by 10m long beds. Weed counts were conducted on two $0.265m^2$ quadrats per replicates prior to any weed removal operation. The hoeing time required for thinning and hand weeding of the two (sub-samples) 30ft beds (21 days after crop seeding) was recorded. During crop harvest the number of heads and the total fresh biomass were evaluated by harvesting two sub-samples of one 10 ft planting line per bed. Results are reported as percent control relative to no preirrigation control.

Results

Davis:

Lettuce trial: Weed density, weeding time, and yield were all influenced by herbicide rate (Figure 4). Pre-irrigation method and weed removal did not significantly affect those variables.
Weeding time was affected by the interaction between pre-irrigation method and herbicide rate therefore a comparison of herbicide treatments separately for each pre-irrigation treatment is appropriate (Figure 5). For each pre-irrigation method the full-rate herbicide treatment required less hand weeding time while the no herbicide treatment the greatest hand weeding time. The interaction between pre-irrigation and herbicide treatment was not significant for weed density so multiple comparisons between pre-irrigation method and herbicide treatment is appropriate (Figure 6). Weed density for the half-rate herbicide treatment on sprinkler and furrow pre-irrigation did not differ from the full-rate on the no pre-irrigation treatment.

Tomato trial: Weed density did not differ among treatments. Weeding time and yield were both affected by herbicide rate; in both cases the full-rate and half-rate herbicide treatments were not significantly different while the no herbicide treatments required more weeding time and had the lowest yield (Figure 7). Weeding time in tomato was influenced by the interaction between pre-irrigation method and herbicide rate as in the lettuce trial; thus, a comparison of herbicide treatments for each pre-irrigation treatment is suitable (Figure 8). For each pre-irrigation method the full-rate and half-rate herbicide treatment were not significantly different and they required less time than the no herbicide treatment.

Salinas:

Preirrigation treatments controlled early season weed emergence (Figure 9). Preirrigation treatments controlled up to 53% of the weeds in the spring planting and 32% of the weeds in the fall planting (Figures 10&11, Tables 1&2).

The results for the spring study indicate that the sprinkler preirrigation was more effective in stimulating weed emergence than the furrow (Table 1). Most preirrigation treatment provide at least 45% control of the weeds in comparison to the control treatment (Figures 9&10). Furrow 7 day treatment increased the weed density relative to the control and the other preirrigation treatments. When furrow or sprinkler irrigation was used the best control of burning nettle emergence was when followed by a 14 day interval. Furrow 14 day preirrigation treatment was also better in controlling other winter annuals such as shepherd's purse (Table 1). Glyphosate application 4 days after planting had no significant effect on weed control (data not shown). The time require for crop thinning, was reduced by 37 and 48% in the furrow 14d and the sprinkler 14 day treatments, respectively, relative to the no preirrigation check.

In the fall study furrow irrigation followed by a 14 day or sprinkler followed by 7 day interval method provided the best weed control of total weeds and annual blue grass (Table 2). However for burning nettle the 14 day interval was best under both the sprinkler and furrow irrigation. The time require for crop thinning was lowest when 14 day interval was used (Table 2).

Discussion

Grower feedback was generally positive, with most growers already utilizing preirrigation in at least a portion of there crops. Most growers favored cultivation compared to the propane flaming, due to more consistent control and equipment availability (they own cultivators). A contact herbicide was also suggested as a replacement for flaming. Growers expressed interest in possibly doing two preirrigations, with a cultivation following each. Growers indicated that they would use the same irrigation type as what they had planned for the succeeding crop.

Summary and Conclusions

We were able to show that preirrigation stimulated weed seed germination sufficiently to reduce the subsequent germination in the crop. Further refinement will be needed to verify the degree day model and incorporate the information into management guidelines.

Project Summary Form

1) Proposal Title : Pre-irrigation Followed by Cultivation or Flaming to Deplete the Weed Seed Bank prior to Crop Planting

2) Principal Investigator W. Thomas Lanini

3) Alternative Practices Use preirrigation to stimulate weed seed germination, and then remove the weeds with minimal disturbance prior to crop planting. Initial data will be used to create a degree day model to predict the proper waiting period between preirrigation and weed removal. A reduction in weed pressure reduces the need for herbicides and/or hand weeding.

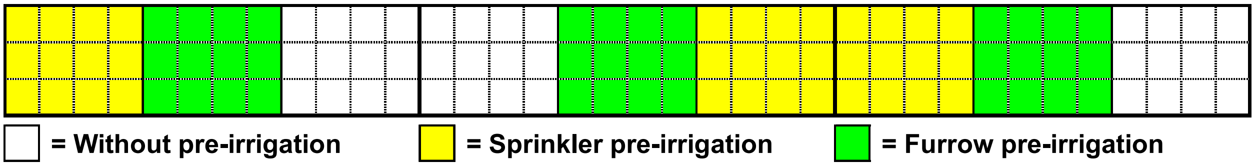
4) Summary of Project Successes We have shown that reductions in hand weeding times and herbicide use could be obtained by preirrigating and removing weeds prior to crop planting. The short duration of the study (1 year) did not allow significant outreach of this project as refining the method was the initial goal which we have obtained. It is hoped that further funding can be obtained to continue the research and outreach efforts.

5) Number of Participating Growers **0**
6) Total Acreage in Project **8**
7) Project Acreage Under Reduced Risk **5**
8) Total Acres of Project Crop **Lettuce – 150,000**
Tomato – 300,000
9) Non-Project Reduced Risk Acres **Lettuce – 3,000**
Tomato – 4,500
10) Number of Participating PCAs **0**
11) Cost Assessment Preirrigation and cultivation costs about $45. The reduction in weed pressure reduces hand weeding time by over 50% and is estimated to save about $50 per acre in hand weeding costs. Growers could also reduce herbicide inputs by 50% which could save $2o to $40. per acre. The delay in planting could be an obstacle if early harvest is critical to reach a market opportunity.

12) Number of Field Days **2**
13) Attendance at Field Days **180**
14) Number of Workshops & Meetings **0**
15) Workshop Attendance **n/a**
16) Number of Newsletters **0**
17) Number of Articles **1**
18) Number of Presentations **1**
19) Other Outreach Activities **None**

Appendices

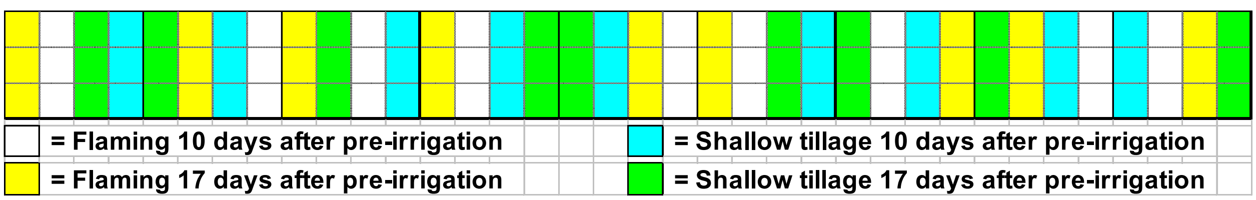
Figure 1. Main plots: Sprinkler, furrow and no pre-irrigation.



Sprinkler pre-irrigation

Furrow pre-irrigation

Figure 2. First split: Weed removal method after pre-irrigation.



Flaming

Shallow cultivation

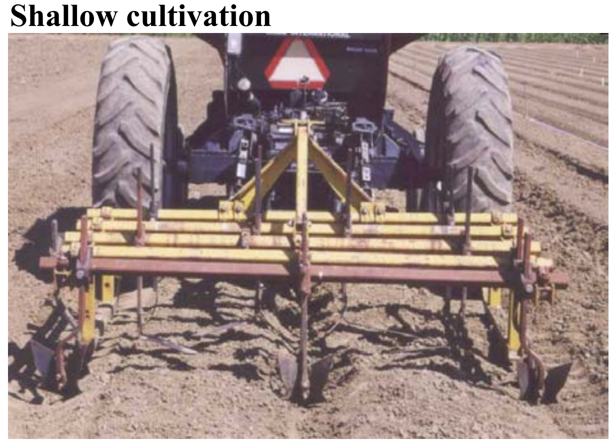


Figure 3. Second split: Herbicide program.

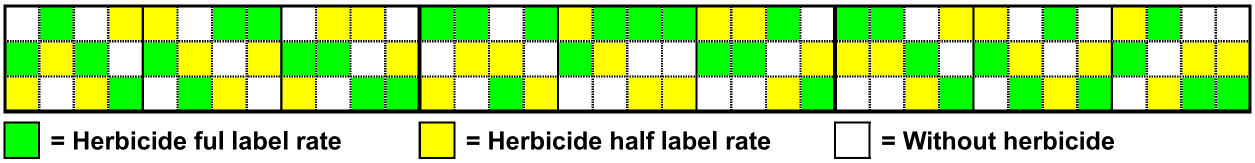


Figure 4. Weed density (#/sq.ft.), weeding time (min/plot) and total yield (lb/33 sq.ft.) for different herbicide rates. Lettuce.

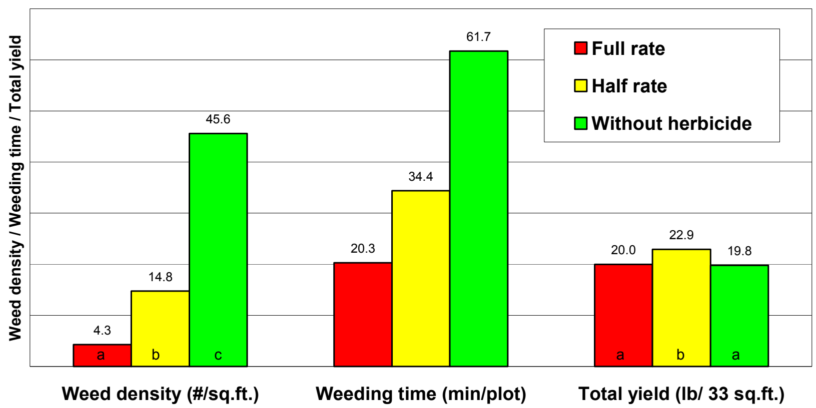


Figure 5. Weeding time (min/plot) for different pre-irrigation treatments and herbicide rates. Lettuce.

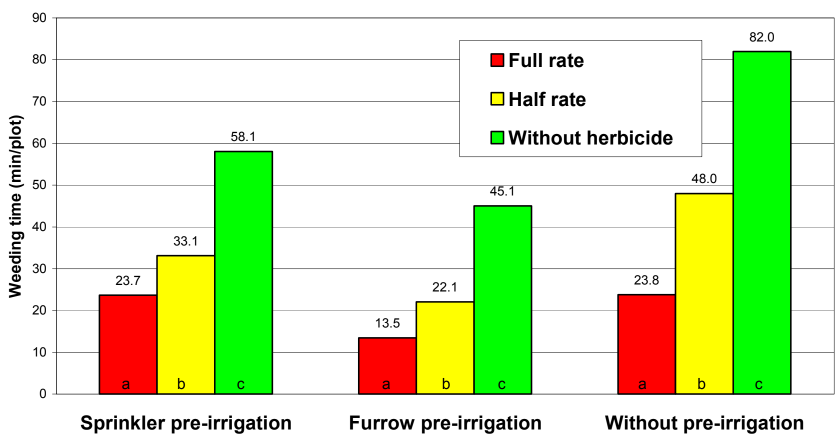


Figure 6. Weed density (#/sq.ft) for different pre-irrigation treatments and herbicide rates. Lettuce.

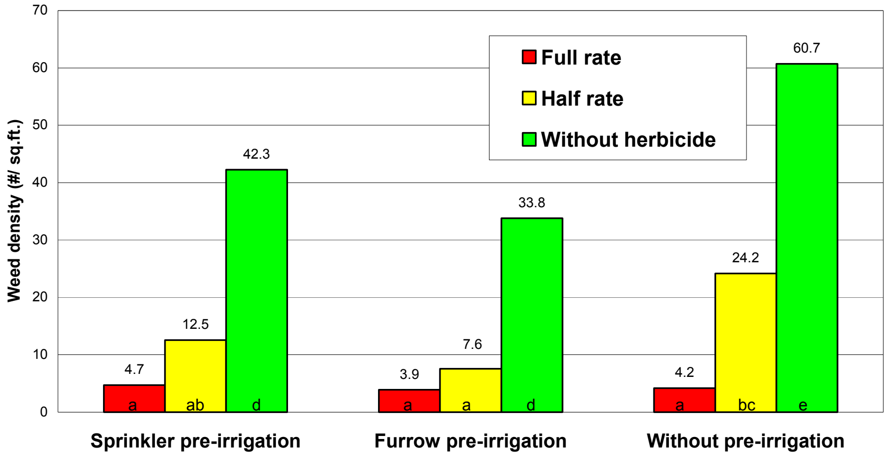


Figure 7. Weed density (#/sq.ft.), weeding time (min/plot) and total yield (lb/ 250 sq.ft.) for different herbicide rates. Tomato.

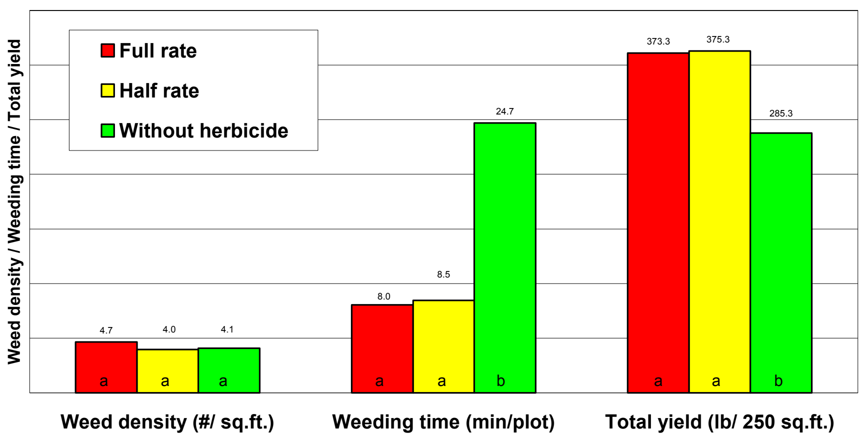


Figure 8. Weeding time (min/plot) for different pre-irrigation treatments and herbicide rates. Tomato.

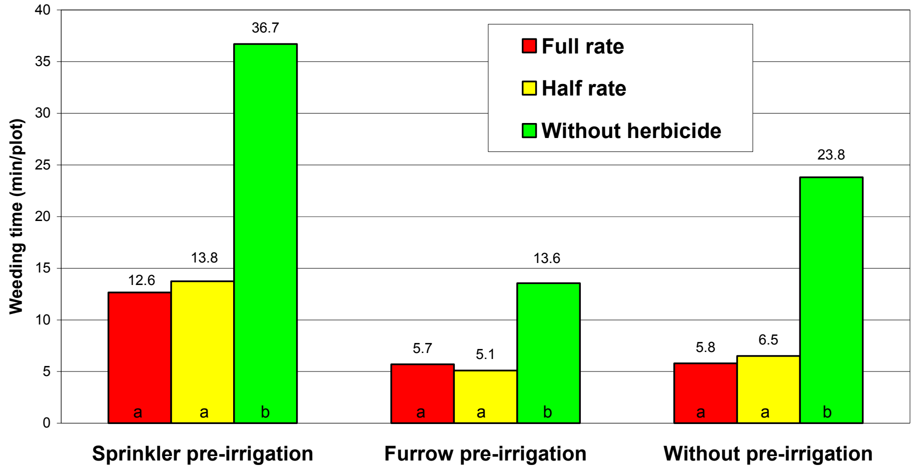


Figure 9. Weed densities in spring-planted lettuce, 21 days after crop planting, in raised beds that were either not preirrigated (left photo) or that received preirrigation two weeks prior to bed shaping and crop seeding (right photo).

Figure 10: Percent of weed control provided by preirrigation treatments and preemergence herbicide application at Spence farm. The differences between the herbicide treatments were significant ($p<0.01$), but the differences between the preirrigation treatments were not significant.

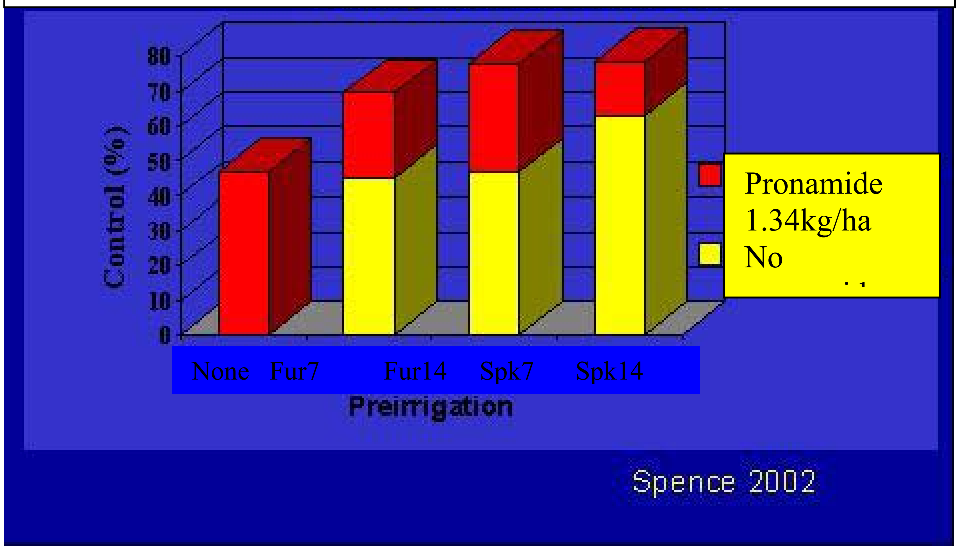


Figure 11: Percent of weed control provided by preirrigation treatments and preemergence herbicide application at Hartnell farm. Both the herbicide and the preirrigation treatments had a significant effect on the weed control ($p<0.01$ and <0.05 respectively).

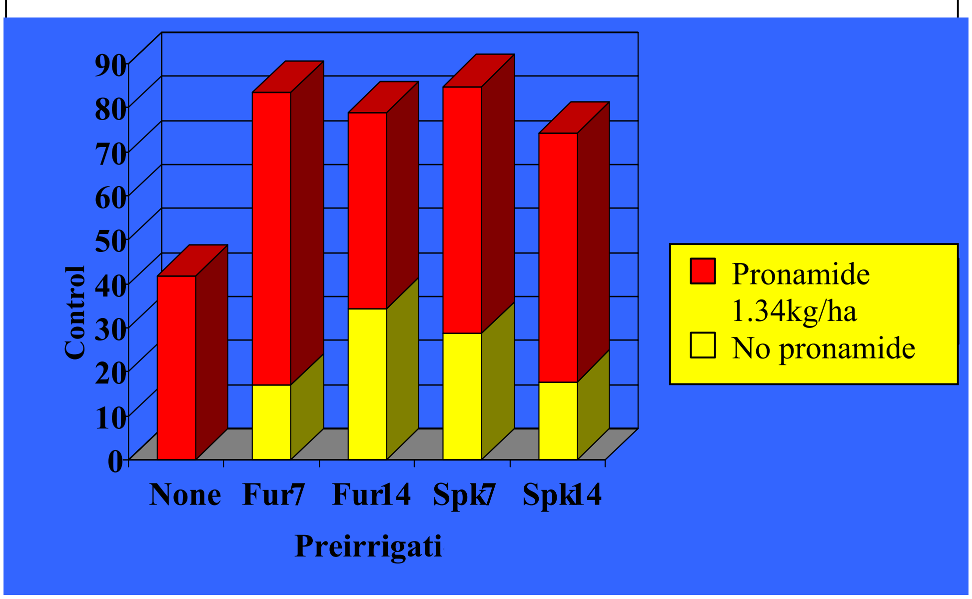


Table 1: Weed densities measured 21d after planting and the time required for thinning and hand weed the spring lettuce at Spence farm.

Weed/ treatment	Total weeds	Burning Nettle[1]	Shepherd's -purse[1]	Hoeing Time[1]
	-------------------------no. m^{-2}	-----------------------		Sec
No preirrigation	341.2 ± 54.7	57.0 ± 2.4	75.5 ± 17.8	254 ± 12
Furrow 7d	383 ± 103.5	31.5 ± 9.6	89.3 ± 27.9	N/A[2]
Furrow 14d	198.0 ± 36.0	0.6 ± 0.6	28.9 ± 6.7	159 ± 20
Sprinkler 7d	160.0 ± 35.0	7.6 ± 2.9	34.6 ± 17	N/A[2]
Sprinkler 14d	177.4 ± 26.9	3.1± 1.8	29.6 ± 9.0	131 ± 7
ANOVA				
Preirrigation df=2	***	**	***	***
Glyphosate df=1	NS	NS	NS	**
Pronamide df=1	***	***	***	***
Preirrigation x Pronamide df=2	NS	***	NS	NS

1- the time (sec.) required for thinning and hand weeding a ten-meter long bed of lettuce.
2- hoeing time was not tested for the 7d treatments.
*- Significant at α=0.05, **-significant at α=0.01, ***- significant at α=0.001.

Table 2: Weed densities 21d after planting and the time required for thinning and hand weed the fall lettuce at Hartnell farm.

Weed/ treatment	Total weeds	Annual bluegrass	Burning nettle	Hoeing Time[1]
No pre-irrigation	---------------------------no. m^{-2}-----------------------			Sec
	574.5 ± 92.3	249.4 ± 60.6	205.7 ± 42.8	186 ± 23
Furrow 7d	477.4 ± 145.3	215.0 ± 65.7	215.1 ± 67.8	158 ± 36
Furrow 14d	378.0 ± 94.2	133.3 ± 45.6	163.5 ± 38.8	146 ± 24
Sprinkler 7d	409.4 ± 138.8	42.8 ± 12.7	264.8 ± 88.1	187 ± 58
Sprinkler 14d	472.3 ± 135.4	256.6 ± 79.5	161.0 ± 47.7	145 ± 18
ANOVA				
Preirrigation df=2	*	**	***	0.06
Pronamide df=1	***	NS	0.052	0.06
Preirrigation x Pronamide df=2	NS	NS	*	NS

(

[1] time (sec.) required for thinning and hand weeding a ten-meter long bed of lettuce.
*- Significant at α=0.05, **-significant at α=0.01, ***- significant at α=0.001.